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The sporadic appearance of non-edible mushrooms in cultures of Agaricus campestris

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(WITH PLATES 3–5)

In studying the culture and development of *Agaricus campestris* during the winter and spring of 1916–1917, I visited some of the largest establishments of commercial mushroom growers in the East and thus have had an opportunity to study the fleshy fungi, other than the commercial varieties of *Agaricus campestris*, which appear sporadically in the mushroom beds. A number of such types for this country have been recorded by Peck* and others, The appearance, in the beds of one of the largest mushroom growers in New York City, of great numbers of *Panaeolus venenosus*, a very poisonous mushroom recently described as a new species by Murrill,† furnished material for the special study of its physiological and toxicological properties and I have published my results along this line elsewhere.‡ As this fungus seems quite dangerous I shall give here some results of observations made on the growth habits and describe another variety or form in which it sometimes occurs.

Panaeolus venenosus Murrill (PLATE 3, FIGS. 1–8).—This species is of interest to mycologists, since up to the present time it has been found only in two widely separated mushroom houses in the vicinity of New York City, in beds spawned for *Agaricus campestris*. The problem of its origin or occurrence in the wild state still remains unsolved. The plants studied were found in several different mushroom houses. In greenhouses which had been imperfectly darkened, better developed plants appeared, such as are shown in FIGS. 2 and 6. The plants grew in small fairy rings, mostly one to two feet in diameter, and in the darker mushroom houses were made conspicuous by the markedly developed white

* N. Y. State Mus. Bull. 157: 67–68, 73, 1911; Bull. 150: 43. 1910.

† A very dangerous mushroom. Mycologia 8: 186, 187. 1916.

‡ The physiological properties of two species of poisonous mushrooms. Mem. Torrey Club 17: 176–201, *pl. 1, 2.* 1918.

tomentose bases of the stipes, as shown in FIG. 7. My observations as to the diagnostic characteristics of the fungus agree with the description given by Murrill. The spore print, however, although blackish in general, appears to have a delicate purplish hue. The shape of the spores is like that of the other species of *Panaeolus*. In my spore prints there is a great number of translucent, possibly immature spores. The following characters are generally present. The sporophores are 6–12 cm. tall; they are cespitose or gregarious. The pileus is 2–5 cm. in diameter and is rather fleshy. Its shape differs with the age, being campanulate in young specimens, later becoming plane and umbonate. The surface is moist and hygrophanous and is fulvous to isabelline in color (Ridgw.) when young, and dark bay when mature. In mature specimens the surface becomes wrinkled, as shown in FIG. 1. The gills are adnately attached and fuliginous in color with a grayish white edge. The stipe is fleshy, but hollow in the center, and in length is approximately two to three times the diameter of the pileus. The surface is striate and is covered with small hair-like scales. The base of the stipe is, as noted above, conspicuously covered with a white tomentum.

The obviously different looking plants, shown in PLATE 4, FIGS. 12–14, appeared during the month of April in one of the greenhouses in which the floor below the benches was used for mushroom culture. These plants were not abundant but were collected twice during the month. The whole of the material weighed about 40 grams, most of which was used in the experiment to determine the physiological and toxological properties. It was found that the plant was poisonous in the same degree as *P. venenosus*. The sporophores in general are like those of *P. venenosus* but they differ materially in the length of the stipe. The stipe is 2–4 cm. long and 5–8 mm. thick; that is, one fifth to one third the size of the stipe of *P. venenosus*. It is striate, however, and is somewhat covered with hair-like scales, as in *P. venenosus*. It is hollow and tapers slightly toward the base. Its color is fulvous and darker at the base than the stipe of *P. venenosus* and the tomentum at the base, noted in *P. venenosus*, is poorly developed and may be lacking. The taste and color are like those of *P. venenosus*. It may be regarded as a form of that species.

Panaeolus campanulatus L.,* which was the first member of this genus to be recognized as poisonous, also appeared in the mushroom beds. These plants appeared late, however, after the crop of *Agaricus campestris* mushroom was exhausted. The size and abundance of the sporophores might make them tempting to the uninitiated. The characteristics of the plants observed were identical with those already described for this species. The color of the pileus may be more accurately described as tilleul buff (Ridgw.) at the center and darker at the margin.

Panaeolus retirugis Fr. (PLATE 2, FIGS. 9–11) was also found in the beds mixed in with the sporophores of *Agaricus campestris*. It was the next most common to *P. venenosus*. A large number of these plants were collected during the month of April and they had been fairly common earlier. Species of *Panaeolus*† in general have been regarded as suspicious, especially *P. retirugis*. This plant was studied toxicologically by Ford and I have also found it to be poisonous to the same degree as *P. venenosus* when applied to the gastrocnemius muscle of the frog and the vagus nerves of frogs and turtles. The characters of the plant, as grown in dung-piles and well-manured lawns, are well known and the specimens collected by me were fairly typical.

The occurrence of *Panaeolus campanulatus* and *P. retirugis* in the mushroom beds may be accounted for by the coprophilous nature of these plants. It is possible that the mycelium of these species of *Panaeolus* are brought into the mushroom houses with the manure or introduced by flying spores in early autumn. The other possibility lies in the method employed for obtaining commercial spawn. It appears that some of the spawn makers in the eastern United States are following the method employed in England and France for obtaining a commercial spawn.‡ This consists of making trenches in the sod, where "spontaneous" mycelium or sporophores of *Agaricus campestris* appear in the

* See McIlvaine & Macadam. One thousand American Fungi 386. 1900.

† See Krieger, C.C.L. Note on the reported poisonous properties of *Coprinus comatus*. Indiana. Mycologia 3: 200–202. 1911. Also Murrill, W. A. A new poisonous mushroom. Mycologia 1: 211–214. 1909.

‡ See Duggar, B. M. The cultivation of the mushroom. U. S. Dept. Agric. Farmers' Bull. 204; 1–25. 1911; The principle of mushroom growing and mushroom spawn making. U. S. Dept. Agr. Bur. Plant Ind. Bull. 85: 1–60. *pl. 1–7*, 1905; Mushroom growing 92. New York. 1915.

pasture, and filling them with thoroughly fermented manure. The vigorously growing mycelium spreads into this manure after several weeks. When this occurs, the manure is taken out of the trenches and slowly dried. This constitutes "virgin spawn," from which the commercial spawn is made. By this method it is conceivable that the mycelia of a number of fungi may be found growing in the "virgin spawn" and be propagated in the commercial spawn. This at least seems to be a plausible explanation for the introduction of *P. venenosus* into mushroom houses. This is supported by the fact that the fungus appeared only after the beds were spawned; as mentioned above it appeared in two widely separated mushroom establishments, both of which, however, were using the spawn from the same spawn maker. How *P. venenosus* escapes observation in the field is still a question that remains unsolved.

It is possible that the plant is a species of *Psilocybe* or *Inocybe* made aberrant by cultural conditions. Another possibility may be that the mycelium never has conditions in the open favorable to the development of sporophores but produces fruit bodies under cultivation only.

Clitocybe dealbata Sow. (PLATE 2, FIGS. 15–17). A species of *Clitocybe* which I have identified as belonging to the variable species known as *Clitocybe dealbata* also appeared. These plants were found in several mushroom houses in great abundance, growing in large clumps in the beds of *Agaricus campestris*. The *Clitocybe* species were found in these houses from January to May.

There are three recognized varieties of *Clitocybe dealbata* Sow., namely, var. *minor* Cooke, var. *deformata* Peck, and var. *sudorifica* Peck. The var. *sudorifica* was later made a species by Peck. The essential diagnostic characteristics of these plants, as given by Peck follow. *C. dealbata* has a white, fleshy pileus with a wavy margin; the gills are close, thin, adnate, and white in color; the stipe is fibrous, equal, and stuffed or hollow. Var. *minor* differs from the typical form of the species in its smaller and more regular form, its opaque gills, and the pleasant farinaceous odor. Var. *deformata* has a thin white, and very irregular pileus with a wavy or lobed margin; the gills are adnate or

slightly decurrent. *C. sudorifica* Peck has an irregularly shaped pileus which often becomes lobed; the gills are adnate and slightly decurrent; the pileus is watery when moist and whitish or grayish white when dry. This species was confused with *C. dealbata*, but the presence of sudorific properties forms a good basis for distinguishing them. The size of the spores in all these forms is approximately the same. While *C. dealbata* and its varieties are generally known to inhabit lawns and grassy places, the typical form of the species and the var. *deformata* have been reported growing in mushroom houses. As far as may be judged from the descriptions and the study of Peck's original herbarium material the species and varieties are separated only with great difficulty, yet I believe that the specimens I found are more like the typical *C. dealbata*, although I have not studied the toxicological properties of the juices of these various plants.

Ford* and his collaborators found that the juices of *C. sudorifica* were very toxic to guinea pigs and rabbits. Peck described earlier the sudorific effect induced by eating this plant. Gillot† and Clark and Smith‡ have recognized and studied the poisonous properties of other species of the genus. In view of the toxic properties of the members of the genus the abundance of this species in a commercial mushroom house is of interest. As in the case of *Panaeolus* the species may have been introduced into mushroom houses through commercial spawn or flying spores.

Tricholoma melaleucum Quél. PLATE 5, FIGS. 21–23, shows a fungus which I found but once in the mushroom houses. The sporophores were discovered in an old mushroom bed. I am not altogether sure of its identity. There are slight discrepancies between my specimens and the description of this species given by Murrill§ (*Melanoleuca melaleuca*). These differences may perhaps be accounted for by the abnormal conditions under which

* Ford, W. W., & Sherrick, J. L. On the properties of several species of the Polyporaceae and a new variety of *Clitocybe*, *Clitocybe dealbata sudorifica* Pk. Jour. Pharm. and Exp. Ther. **2**: 549–558. 1911; Further observations on Fungi, particularly *Clitocybe sudorifica* Pk., *Pholiota autumnalis* Pk. and *Inocybe decipiens* Bres. Jour. Pharm. and Exp. Ther. **4**: 321–332. 1913.

† Etude médicale sur l'empoisonnement par les champignons. Lyon. 1900.

‡ Toxcological studies on the mushrooms *Clitocybe illudens* and *Inocybe infida*. Mycologia **5**: 224–232. *pl. 91*. 1913.

§ N. Am. Fl. **10**^{2}: 7. 1914.

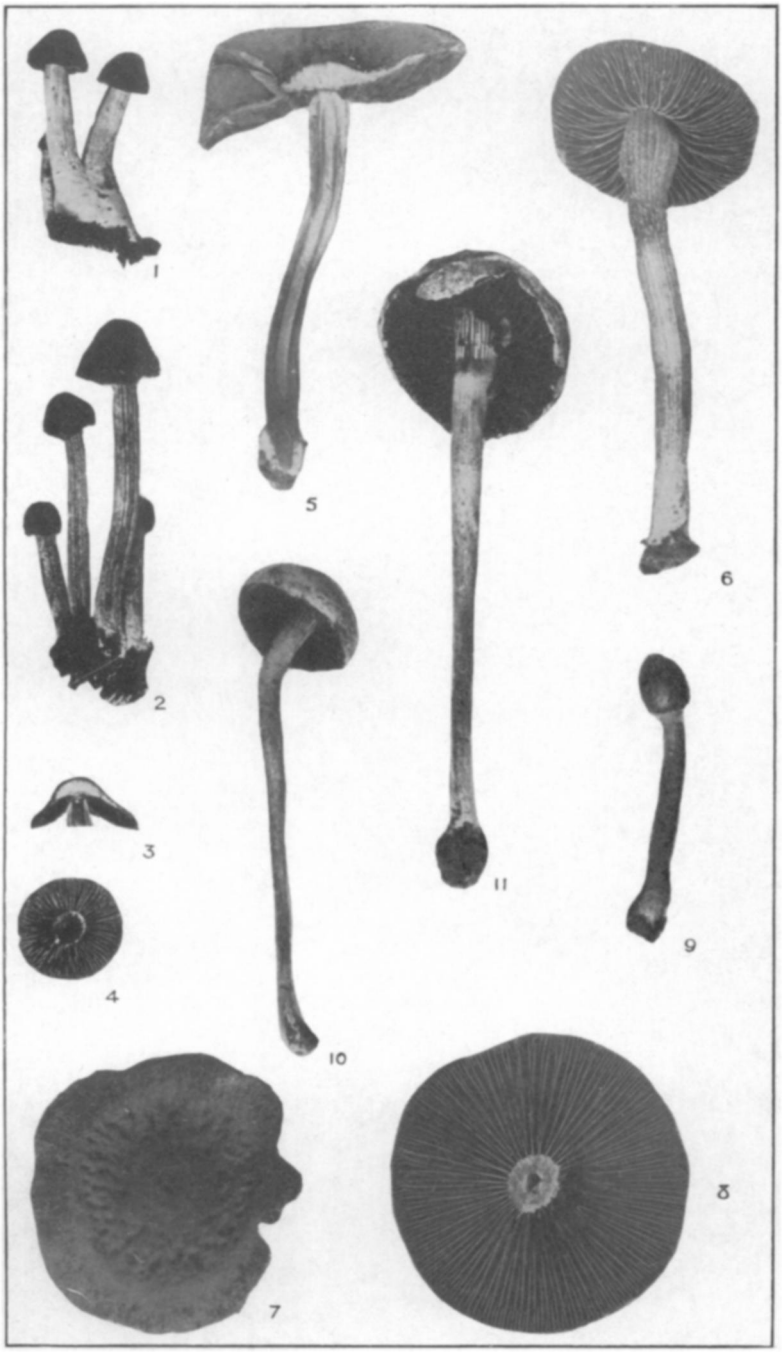
these plants grew. However, the description and published illustrations* of *Tricholoma melaleucum* best fit this plant. The sporophores I found are somewhat larger than the type described by Murrill, whose herbarium material I compared with my plants. The pileus is larger than this type and measures 3–9 cm. in diameter, while in height the plant agrees with the description. The pileus is thin, convex to plane and depressed. The margin is lobed and may become divided into a number of segments as shown in FIG. 23. The color of the pileusis drab to light drab (Ridgw.). The gills in these specimens were not very white, as described by Murrill, but drab gray. The spores of this plant agree perfectly with those of *T. melaleucum*. The stipe is even, although it may be enlarged at the top and at the base. The surface is reticulately veined as shown in FIG. 21 and in this respect is unlike the description. Its color agrees with the description. Up to the present *T. melaleucum* has been reported as found only in woods, fields and lawns. Its habit is solitary and the plants found in the mushroom beds were solitary, although they tended to be cespitose.

Peziza domiciliana Cooke† (PLATES 4, FIGS. 18–20). The *Peziza* shown in FIGS. 18–20 is common in all the mushroom houses studied. It makes its appearance as early as November and can also be found late in the spring. The plants generally appeared before and during the growth of the mushrooms. I am indebted to Dr. Seaver for the identification. While the plants agree in the main with the description given for *P. domiciliana*, there are some differences. The apothecia grow singly or gregariously but never caespitose. The outer surface of the cup has a white granular appearance and the color of the hymenium is pale ochraceous salmon (Ridgw.) when young, to Dresden brown, when old, instead of ochraceous buff or dungy buff as given by Overholtz and Seaver. While the spores are ellipsoidal and hyaline when young, and in this agree with the description already published, they are slightly smaller in size.

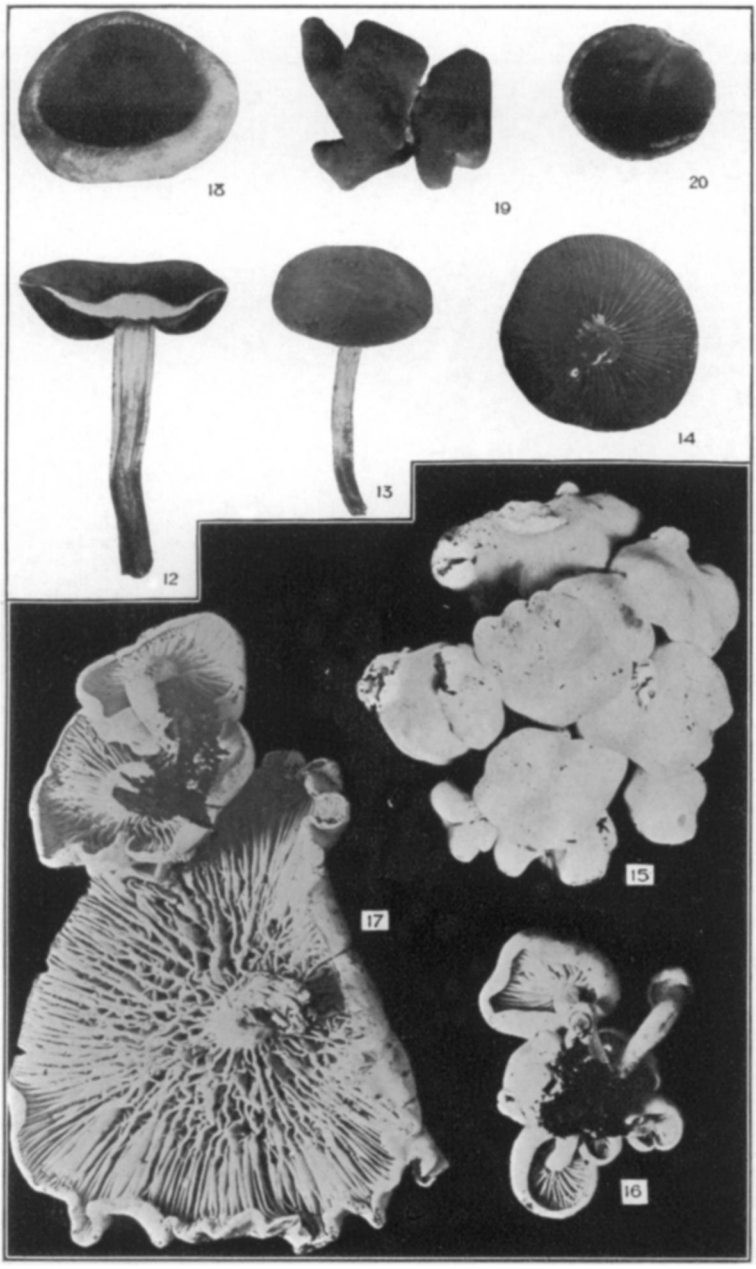
A considerable number of species of *Coprinus* appeared in the

* See Barla. Les champignous des Alpes-Maritimes *pl. 46, f. 8–15.* 1888.

† See Seaver, F. J. Development of the cup Fungi. Mycologia **8**: 195–198. *pl. 188, 189.* 1916.



LEVINE: NON-EDIBLE MUSHROOMS



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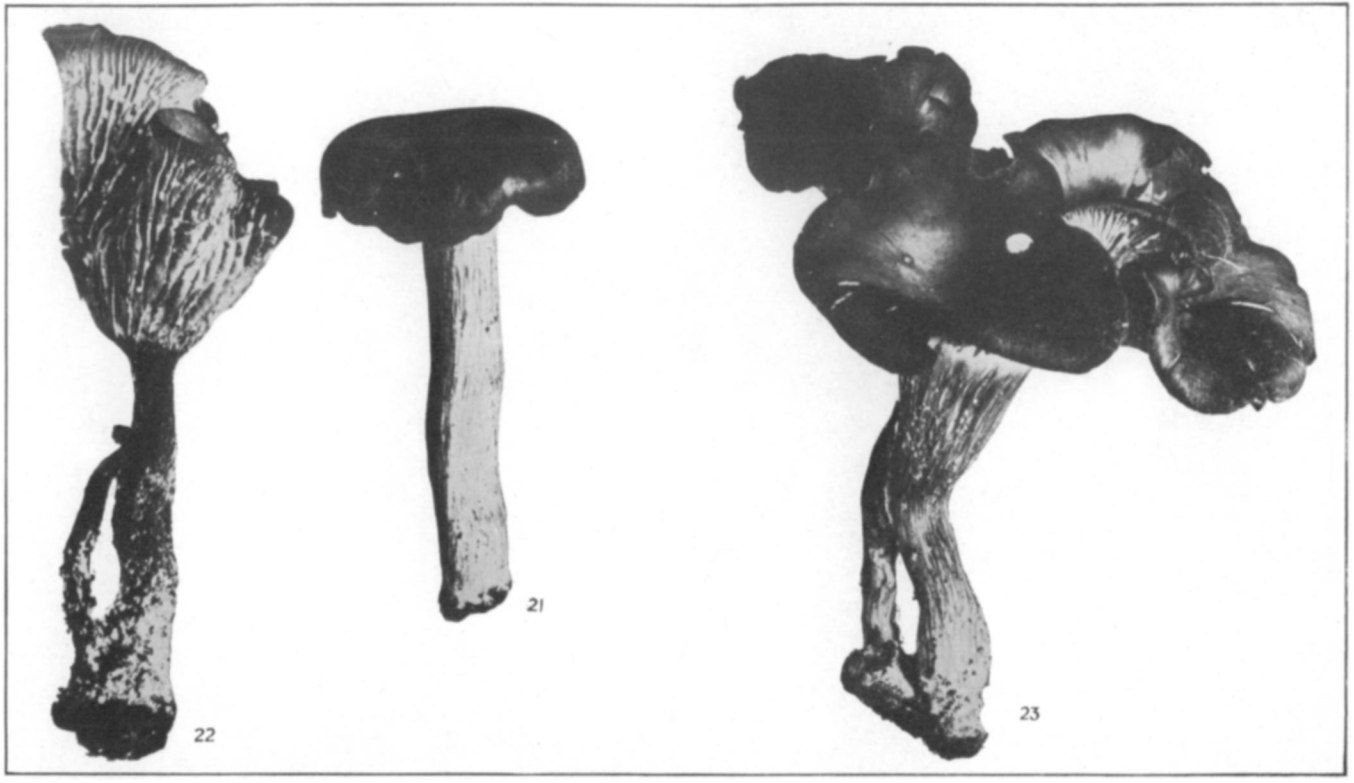

LEVINE: NON-EDIBLE MUSHROOMS

compost after the beds were made and several species of *Poria* were found on the wooden framework in some of the more moist houses, but I shall not report on them at this time.

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Description of plates 3-5.

In PLATES 3 and 5 the natural sizes of the plants are represented; in PLATE 4 the figures are slightly reduced.

PLATE 3

FIGS. 1–4. Young stages in the development of *Panaeolus venenosus* Murrill.

FIGS. 5–8. Mature stages of *Panaeolus venenosus*.

FIGS. 9–11. Stages in the development of *Panaeolus retirugis* Fr.

PLATE 4

FIG. 12. Longitudinal section of a mature carpophore of *Panaeolus venenosus* with a short stipe.

FIG. 13. Young carpophore of *Panaeolus venenosus* with a short stipe.

FIG. 14. The under surface of the pileus of *Panaeolus venenosus* with a short stipe.

FIGS. 15–17. Clusters of *Clitocybe dealbata* Sow., showing the upper and lower surfaces of the pilei.

FIGS. 18–20. Mature stages in the development of *Peziza domiciliana* Cooke.

PLATE 5

FIGS. 21–23. Different stages of a fungus that most closely resembles *Tricholoma melaleucum* Quél.